




Increasingly rare along the Anacostia River since the late 1800s the American lotus (lower left and middle of photo) is making a comeback at Anacostia Park near Benning Bridge in Washington, D.C. National Capital Parks–East, in partnership with the Potomac Electric Power Company, restored the wetland habitat and transplanted native lotus tubers, which flourished in 1999.

For park ecosystems to be fully functional, the National Park Service must at times act as natural resource physician. First, a sick patient requires a diagnosis. What is the source or cause of the dysfunction? Are the underlying processes still retained, or can they be repaired so that with some treatment the patient can be healed? Then, based upon the latest and most complete scientific information, a team of technical specialists is assembled to plan and carry out the necessary restoration or rehabilitation. If all the pieces have been preserved, as Aldo Leopold warned is critical, then it may be possible to restore the natural function to an ailing ecosystem. But this will not happen without considerable expense, effort, and time. Nevertheless, as this Year in Review illustrates, ecological restoration is a fundamental role of the National Park Service and NPS efforts are responsible for correcting a variety of problems and returning natural resources to proper function. The many benefits bestowed on parks by these activities live on for all to contemplate, learn from, and enjoy.

Wetlands

Restoring the American lotus to the nation's capital

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In Washington, D.C., much of the tidal Anacostia River is managed by National Capital Parks–East as the 1,375-acre Anacostia Park. The Anacostia has been severely changed by the combined effects of agriculture and urban growth over 300 years. Early in the 20th century this slow-moving river silted in and then was walled and channeled. Today it has lost almost all its historic wetland habitat. One of the consequences of this loss was the disappearance of the spectacular American lotus, *Nelumbo lutea*.

American lotus is one of a few native species to grow in the low marsh vegetation zone of the freshwater tidal system, stabilizing sediments and extending wetland edges. Growing from banana-like rhizomes or tubers, the lotus has stiff, 5-foot stems supporting leaves that resemble inverted umbrellas, and large, yellow, fragrant flowers appearing in summer months. Once established, the species forms large colonies. A favored food of early American Indians throughout its range, the lotus also provides food and shelter for wildlife.

The American lotus had been absent from the Anacostia for such a long time that it was overlooked in recent wetland restoration projects along the river. But a review of early photographs and botanical lists revealed that the plant had been abundant before its habitat was destroyed.

Based on this information, National Capital Parks–East decided to restore the plant to the wetlands in Anacostia Park. A recently created wetland in the park, located at Benning Bridge, provided the low marsh mudflat habitat required by the lotus. The site also had the advantage of being highly visible to the public as they drove, walked, or rode past on the METRO train. Interpretive signs on the history of the Anacostia River, the importance of wetland ecosystems, and wetland vegetation including American lotus were produced as part of this project and erected on-site.

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To begin restoration, National Capital Parks–East needed to find an accessible native population of the lotus near the planting site. A search of the botanical voucher collections at the Smithsonian Institution's Natural History Museum indicated that several local sites had historically supported lotus populations. Discussing these records with local botanists and biologists familiar with contemporary lotus populations on the Potomac River and with staffs of the State Heritage Programs of Maryland and Virginia, resource managers at National Capital Parks–East identified a native stand 40 miles away at the U.S. Marine Corps Base in Quantico, Virginia.



Transplanting lotus rhizomes is grubby work. Resource managers first collect the plants from a donor site by lying facedown in the mud, carefully feeling for the delicate tubers, which grow at an arm's length below the soil surface. Protection from air and quick transplanting proved to be important factors for success.

Digging lotus tubers is grubby work. The tubers are extremely delicate and must be dug bare-handed just as the shoots emerge from the mud in April. They grow an arm's length from the soil surface and are collected by feel, digging carefully and slowly so as not to damage the tender shoot. Collecting these plants entails lying facedown on the mud during low tide! With the permission of the U.S. Marine Corps, resource managers collected the plant for three consecutive years; each spring required a new crop of volunteer diggers, as nobody wanted the experience more than once.

Resource managers found that lotus tubers did best when protected from air and transplanted quickly to their intended habitat. Early transplanting attempts were scuttled by incorrect handling and animal predation in the holding ponds. In spring 1998, 26 tubers were dug and packed in

mud. Half were taken to the USDA Plant Materials Center in Maryland for propagation as future planting stock. The rest were potted and held in outdoor ponds at the historic Kenilworth Aquatic Gardens, a unit of the national park system, then transplanted to the restoration site. By August the plants had spread, sending shoots beyond their protective cages (necessary to prevent wildlife predation). In their second summer, in 1999, the plants grew at a spectacular rate, densely filling the wetland mudflat previously devoid of vegetation. The lotus produced vigorous vegetative growth as well as flowers and viable seeds.

In spring 2000 a major, 42-acre wetland restoration at Kinsman Lake will include American lotus collected and grown during this project. After more than 60 years, this beautiful plant will continue its return to the banks of the Anacostia River in the nation's capital.

Rehabilitating a wetland-riparian ecosystem at Pecos National Historical Park

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In addition to preserving 10,000 years of human history, Pecos National Historical Park (New Mexico) is responsible for managing riparian and wetland habitats along Glorieta Creek and the Pecos River. One such area, a half-mile stretch of floodplain and terraces along lower Glorieta Creek, was mined for sand and gravel before becoming part of the park. Once mining ended in the mid-1980s, ranchers bulldozed the remaining material into a series of levees and dams, creating two reservoirs on 5.6 acres. These reservoirs soon became a threat to the ecology of Glorieta Creek. Floodwaters periodically swept thousands of fish from the creek into the reservoirs, where they were trapped and later died as the ponds dried. Flooding also caused breaches in the progressively weakening reservoir walls, washing sediment into the creek. Although ranching and 1850s-era Hispanic farming are primary cultural themes of the park, the National Park Service

determined that removal of the reservoirs would not diminish these themes. Therefore, park managers sought technical assistance and funding to create a more stable, functional wetland-riparian ecosystem in this highly disturbed landscape.

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Rehabilitation of the site was a cooperative effort among the park, the NPS Water Resources Division, Colorado State University, the Tierra y Montes Soil and Water Conservation District, and the NPS Intermountain Region. In the early planning phases the design team monitored surface and groundwater levels, created existing-condition topographic and water-table maps, completed biological inventories, and began environmental and cultural compliance. In summer 1999 the environmental assessment for the project was approved and the design team prepared the final grading plan, which called for removing the levees



Most earthmoving contractors are experienced in creating smooth surfaces needed for roads or parking lots, but may not know how to interpret the degree of undulation or “roughness” called for in wetland projects. For the Glorieta Creek rehabilitation project, a member of the design team was on-site at all times during the earthmoving phase, interpreting these details for the contractor and checking elevations with a laser level.

and dams and reshaping the site to create a native wetland-riparian system. Although portions of the site would be planted with native species to stabilize soils and promote rapid revegetation, the ecosystem would be designed to be self-perpetuating, with revegetation largely from natural seed sources and processes.

The final grading plan was based on thorough knowledge of site hydrology obtained through a network of 21 wells and surface water gauges, and on an understanding of plant community-soil-hydrology relationships in nearby reference communities. The design called for a number of depressions and mound features, and specified a rough, undulating surface that would allow a diversity of wetland plants to establish where conditions are favorable. The result would be a complex of ponds, wet meadows, willow thickets, and cottonwood galleries modeled after nearby undisturbed habitats.

With funding and assistance from the NPS Water Resources Division, the NPS Geologic Resources Division, the Tierra y Montes Soil and Water Conservation District, and the park, earthmoving began in October 1999. A critical step was stationing a member of the design team on-site to supervise the earthmoving. Most contractors are experienced

in creating smooth surfaces needed for roads or parking lots, but may not know how to interpret the degree of undulation or "roughness" called for in this wetland rehabilitation project design. The on-site supervisor interpreted these details for the contractors, checked elevations, and identified issues to be addressed by the full design team during its weekly site visits. By mid-November the contractors had completed this phase, moving over 30,000 cubic yards of material in the process. In early December, upland areas were seeded with native grasses and biodegradable erosion-control blankets were installed where necessary.


In spring 2000, park staff, project cooperators, and volunteers planted more than 1,000 rooted willow and cottonwood cuttings collected from the surrounding area. Additionally, thousands of native sedges, rushes, bulrushes, and other wetland species grown from local seed sources were planted. Park staff have begun a program of weed and exotic plant control, and follow-up monitoring of water levels and plant establishment and survival is planned for the 2000 growing season. Over the longer term the park envisions a trail on the edge of the project area for public enjoyment and interpretation of the cultural landscape; the wetland rehabilitation process; and the waterfowl, songbirds, muskrats, deer, and other wildlife that are expected to thrive there.

The Pueblo Colorado Wash demonstration project

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Hubbell Trading Post National Historic Site (Arizona) is partnering with Navajo Nation agencies and the Arizona Water Protection Fund through a three-year grant (1998–2000) to restore a 1.5-mile section of the Pueblo Colorado Wash. The Pueblo Colorado Wash is the most significant natural resource at Hubbell Trading Post and is by far the most important element responsible for the presence of the cultural resources for which the national historic site was established. As a result of historic and modern disturbances (including stream channeling by the National Park Service), the wash had become severely degraded. These disturbances led to the establishment of dense stands of nonnative vegetation (primarily tamarisk and Russian olive), eliminating the view of the stream channel and de-emphasizing the cultural connection of the waterway for visitors.

In 1998, the Arizona Water Protection Fund awarded the Pueblo Colorado Wash restoration project a three-year grant to promote the use of low-cost, low-tech approaches to stream enhancement and to focus attention on the project as a successful demonstration for other waterway enhancements within the Navajo Nation. Project activities have resulted in removal of livestock and exotic plant species from three-fourths of the 1.5-mile section of the wash. Additionally, a fence has been established to eliminate livestock trespass. Natural materials have been used to build in-stream structures to add sinuosity and floodplain to the channel through induced stream meandering and sediment deposition. Finally, the wash has been revegetated with native plant materials.

Monitoring activities in 1999 have revealed natural recruitment of native in-stream vegetation in addition to natural regeneration of native cottonwoods and willows. Groundwater levels and the quantity of water maintained in the stream have increased as a result of nonnative plant removal. In summer 1999 the increased channel capacity and sinuosity greatly reduced bank erosion during an ex-

tremely high-water monsoon event (9,000 cubic feet per second). From its humble beginnings as a volunteer initiative, the project has grown into a multijurisdictional,

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multi-interest conservation partnership to enhance and conserve this significant waterway. Additional partners, including the U.S. Environmental Protection Agency

(EPA), Public Land Corps grants, the Student Conservation Association, and numerous volunteers, have also been critical in the success of the restoration project. In 1999 the project was awarded an additional grant, the EPA “Five Star Restoration Partnership” grant, and the park was presented with a plaque as the first EPA “Five Star Restoration Site.” For all its erosion control and native plant revegetation achievements, perhaps the greatest success is that the Pueblo Colorado Wash is again visible to the public, reconnecting the cultural resources at Hubbell Trading Post with their appropriate natural setting.



Volunteers construct small water-diversion structures within Pueblo Colorado Wash to encourage the formation of stream meanders. The work is part of a three-year demonstration restoration project at Hubbell Trading Post National Historic Site.

Integrating Natural and Cultural Resource Management

Greening earthworks: Managing historic structures with native plants

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Stones River National Battlefield has taken on the challenge to preserve a portion of the largest earthen fortification built during the Civil War. The Union Army constructed the 200-acre fort in Murfreesboro, Tennessee, after winning the Battle of Stones River in early 1863. The National Park Service acquired 25 acres of the fort in 1993 that were so overgrown with invasive exotic plant species that few people even knew the fort existed.

Opening the area for interpretation presented a preservation challenge: How could the National Park Service remove the dense growth of invasive exotic plants without exposing the soil to erosion? In response to 1987 legislation that directed the Secretary of the Interior to preserve the earthworks, the NPS Southeast Region developed the *Preservation and Management Plan, Environmental Assessment: Remnants of Fortress Rosecrans* in 1991. Following the recommendations of the *Earthworks Landscape Management Manual*, (1989, prepared under contract by Andropogon Associates, Ltd., of Philadelphia), the park decided to open the canopy, clear the understory, and establish native grasses as a low-maintenance ground cover.

“Native grasses stabilize the earthen walls and allow the structures to be legible.”

Native grasses stabilize the earthen walls and allow the structures to be legible. When interpreted through wayside exhibits, the earthen components of the fortress can be seen and understood by visitors. Thus, in 1993, NPS crews cleared the understory of the invasive exotics Chinese privet, bush honeysuckle, Japanese honeysuckle, periwinkle, and kudzu. They selectively removed trees, leaving some to provide shade for the trail to be constructed. Of the species removed, some, like sassafras and black locust, form large colonies by sprouting aggressively from their roots. Since the park did not initially treat the exotics or trees with herbicide after cutting them, many resprouted, showing tremendous growth in just one season. Project staff seeded the area with warm-season native grasses, but this posed the challenge of continuing to clear the area of invasive exotics while encouraging the barely established grasses.

The park chose warm-season native grasses as a ground cover to preserve the earthworks for several reasons. First, warm-season grasses are a major component of the regional flora. Although slower to establish, grasses such as broomsedge, side-oats grama grass, and little bluestem are self-seeding and require little maintenance once established, offering a labor- and cost-reducing alternative to fescue, the typical lawn and turf grass in the area. Moreover, the Tennessee Exotic Pest Plant Council lists fescue as an invasive exotic ranked as a significant threat to natural areas and native plant communities.

The park manages nonnative evergreen species with herbicide during the dormant season. Nonnative species that are not evergreen are treated mechanically, either by hand pulling or by cutting before seed is set, and by using a broadleaf herbicide to avoid damaging the grasses.

Since the initial clear-cutting and seeding, the park has been managed for exotic and weedy species year-round. Many of the exotics are persistent, and management requires long-term commitment. Additionally, the park has documented an increase in the numbers and abundance of a variety of native species including forbs and grasses returning on their own.

During 1999, the earthworks crew continued to manage for native grasses. Large expanses of sapling black locust and sassafras were sprayed with a broadleaf herbicide, opening areas for further seeding. Aggressive annual weeds such as ragweed, horseweed, and fireweed were identified and cut before setting seed. In November 1999 the park contracted to treat the entire site for evergreen exotics, effectively opening areas for native grasses that were once dense with periwinkle and Japanese honeysuckle. However, success has been limited on the steepest walls of the earthworks where seed is likely to wash away before it can take hold. To remedy this problem, the park planted more than 7,000 rootstocks of mature native grasses in spring 2000.

Educating coworkers, adjacent property owners, and community members on the identification of exotics and their impact on the environment is crucial to habitat restoration projects. By adopting an integrated approach to managing cultural and natural resources, Stones River National Battlefield is working to achieve maintenance objectives that not only preserve historic resources, but also achieve the goal of replacing exotic species with native plants.



The ambitious restoration project at *Stones River National Battlefield, Tennessee, entails the meticulous management of native plant species for the preservation and interpretation of a cultural resource: the largest earthen fortress built during the Civil War. Follow-up vegetation monitoring, shown here, has documented an increase in numbers and abundance of several native grasses and forbs.*

AFRICAN ORYX EXPELLED FROM WHITE SANDS

White Sands National Monument, New Mexico, is on its way to being oryx-free. The large African antelope (*Oryx gazella*) is seriously degrading native plants and soils at the monument. The New Mexico Department of Game and Fish released approximately 100 oryx adjacent to the monument in the 1960s and early 1970s with plans to establish a population of large game for public hunting. However, by the late 1990s the population had increased to more than 3,000 animals despite public hunting outside the monument. In 1996 a boundary fence was constructed around the 145,000-acre monument to exclude the semisolitary, wandering species, but a 1999 survey estimated the population within the monument to be about 140 animals. In a planned three-year operation involving numerous partners, the National Park Service drove 46 oryx out of the monument in 1999 using helicopter hazing methods. In February 2000 an additional 31 animals were tranquilized and relocated by helicopter to the adjacent U.S. Army–White Sands Missile Range. Further actions will be taken in 2000 and 2001 to remove additional oryx from the park using nonlethal methods.